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Bioventing Pilot Test Work Plan for Spill Site No. 1, Building 457 Area, and UST 702



Eaker Air Force Base Blytheville, Arkansas

Prepared For

Air Force Center for Environmental Excellence Brooks Air Force Base, Texas

and

Air Force Base Conversion Agency/OL-J Eaker Air Force Base, Arkansas

February 1996



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DRAFT BIOVENTING PILOT TEST WORK PLAN FOR SPILL SITE NO. 1, BUILDING 457 AREA, AND UST 702

EAKER AIR FORCE BASE BLYTHEVILLE, ARKANSAS

Prepared for:

Air Force Center for Environmental Excellence Brooks AFB, Texas

and

Air Force Base Conversion Agency/OL-J Eaker AFB, Arkansas

February 1996

Prepared by:

Parsons Engineering Science, Inc. 1700 Broadway, Suite 900 Denver, Colorado 80290

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BIOVENTING PILOT TEST WORK PLAN FOR SPILL SITE NO. 1, BUILDING 457 AREA, AND UST 702 EAKER AIR FORCE BASE BLYTHEVILLE, ARKANSAS

1.0 INTRODUCTION

This work plan presents the scope of a multiphase bioventing pilot test for *in situ* treatment of fuel-contaminated soils at Spill Site No. 1, Building 457 Area, and underground storage tank (UST) 702, at Eaker Air Force Base (AFB) (the Base), near the city of Blytheville, Arkansas. The pilot test will be performed by Parsons Engineering Science, Inc. (Parsons ES) [formerly Engineering-Science, Inc. (ES)]. The primary objectives of the proposed pilot tests are: 1) to assess the potential for supplying oxygen throughout the contaminated soil interval; 2) to determine the rate at which indigenous microorganisms will degrade fuel when supplied with oxygen-rich soil gas; 3) to evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated to concentrations below regulatory standards; and 4) to determine design parameters, such as well spacing and flow rates, for full-scale bioventing system design.

The pilot tests will be conducted in three phases. The initial phase will consist of investigative drilling with a Geoprobe truck-mounted direct-push sampling rig, soil sampling, and vapor monitoring point (MP) installation at each site. Up to five vapor MPs will be installed with the Geoprobe rig at each site. The second phase will consist of construction of up to two air injection vent wells (VWs), and conducting an in situ respiration test and an air permeability test at each site. Existing groundwater monitoring wells may be used as VWs or additional vapor MPs if their screens extend above the saturated zone. Proposed VW and MP boring locations will be sampled and field screened for volatile organic compounds (VOCs) (using a photoionization detector [PID] and a total volatile hydrocarbon analyzer [TVHA]), prior to the final installation. This initial testing is expected to take approximately 3 weeks. During the last phase, the bioventing systems will be operated and monitored for a 1-year period. At the end of this period, soil gas sampling and respiration testing will be performed to determine the level of cleanup achieved after 1 year of treatment.

An initial pilot test results report will be prepared following completion of the initial phase of testing. This report will summarize the test results and make specific recommendations for continued system operation and/or expansion at each site. If the initial phase of testing proves bioventing to be an effective means of remediating soil

contamination, pilot test data will be used to prepare a conceptual full-scale system design and cost estimate, and to estimate the time required for site cleanup. At the end of the 1-year testing phase, a letter report will be prepared to summarize long-term testing results. Additional background information on the development and recent success of bioventing technology is presented in the protocol document entitled *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Hinchee *et al.*, 1992). This protocol document will serve as the primary reference for pilot test well designs and the detailed procedures to be used during the tests.

This work plan was developed following discussions among representatives from the Air Force Center for Environmental Excellence (AFCEE), Eaker Air Force Base Conversion Agency (AFBCA), and Parsons ES at a meeting held at the Base on November 16, 1995, the statement of work (SOW) for this project (US Air Force, 1994), and on a review of existing site characterization data. All the field work will follow the health and safety procedures presented in the program Health and Safety Plan for Extended Bioventing (Parsons ES, 1995), and the site-specific addendum to the program Health and Safety Plan. This work plan was prepared for AFCEE and AFBCA.

2.0 SITE DESCRIPTION

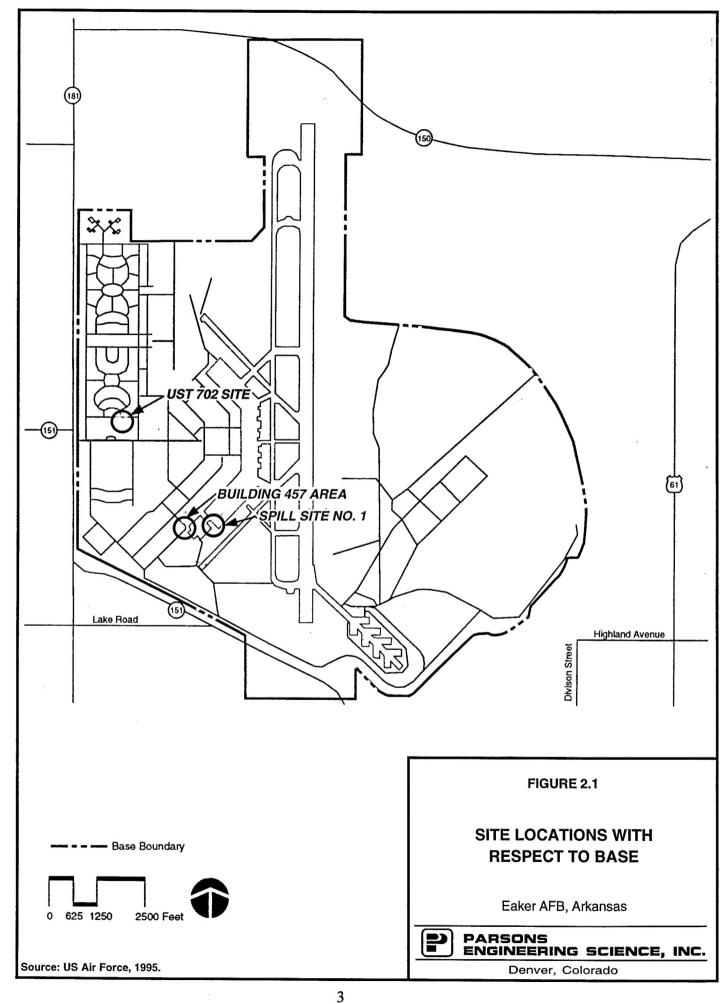
2.1 Spill Site No. 1

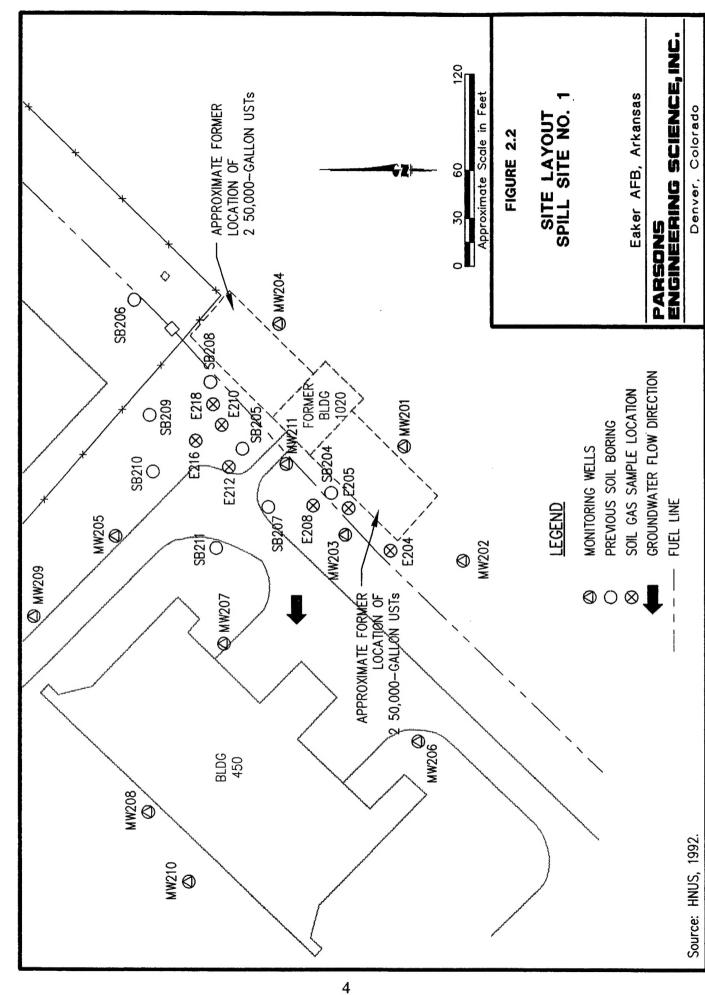
2.1.1 Site Location and History

Spill Site No. 1 is located near former Pumphouse No. 4 (Building 1020), between Pumphouse No. 2 (Building 1235) and the southeastern terminus of the flight apron. The site location relative to the Base is shown on Figure 2.1. Four 50,000-gallon underground storage tanks (USTs) containing jet propulsion fuel grade 4 (JP-4) were formerly located northeast and northwest of Pumphouse No. 4. The site layout is shown in Figure 2.2. Ten-inch and 6-inch pipelines were used to transfer fuel from the four tanks to the aircraft fueling hydrants on the flight apron. Pressure testing of the fuel hydrant system, performed in 1973, indicated the presence of a leak in the 6-inch fuel line, northwest of Pumphouse No. 4 (HNUS, 1994). During the subsequent pipeline repair, petroleum-contaminated soils were observed in the shallow excavation. The time-frame and amount of fuel released are unknown. The site is currently vacant and inactive.

2.1.2 Site Geology and Hydrology

Because bioventing technology is applied to unsaturated soils, this section will only discuss soils above the shallow aquifer. Subsurface soils at Spill Site No. 1 primarily consist of silty clay materials with interbedded sandy lenses to a depth of approximately 10.5 feet below ground surface (bgs). The proposed bioventing site is covered with grass. Groundwater was encountered at a depth of approximately 10 to 13 feet bgs during September 1995; however, seasonal fluctuations vary (HNUS, 1995a).





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2.1.3 Site Contaminants

The primary contaminants at this site are JP-4 petroleum hydrocarbons, which have been detected in the soils. The source of the fuel contamination was the leaking transfer pipeline. The highest concentrations of petroleum hydrocarbons in soils are found west, north, and northwest of Pumphouse No. 4 (Building 1020). The highest concentrations of organic compounds were found in "smear zone" soils near the water table in boreholes SB204, SB207, and SB208 (Figure 2.2). Total petroleum hydrocarbons (TPH) were detected at 9,500 milligrams per kilogram (mg/kg), and total benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected at 295.2 mg/kg in soil boring SB208 at a depth of 9 feet bgs (HNUS, 1994). Soil borehole SB204 contained 5,200 mg/kg of TPH and no BTEX at a depth of 6 to 7 feet bgs. Vadose zone soil contamination appears to be confined to the area between and adjacent to soil borings SB209 (north), and SB211 (west), monitoring well MW202 (south), and former Pumphouse No. 4 (Building 1020). The extent of contaminant migration in the smear zone along the water table may have been limited by site conditions (i.e., natural attenuation, low permeability aguifer), because TPH and BTEX compounds were not detected in significant concentrations downgradient from the site (wells MW205, MW206, and MW207) (HNUS, 1994).

Parsons ES conducted an initial soil gas survey of existing monitoring wells at Spill Site No. 1 in November 1995. Table 2.1 presents the results of the soil gas survey. Low oxygen concentrations measured at monitoring wells MW203 and MW207 indicate that without the benefit of air injection, natural biodegradation of JP-4 compounds may be limited. Additionally, monitoring well MW211 had a total volatile petroleum hydrocarbon (TVH) concentration of greater than 10,000 parts per million, volume per volume (ppmv). MW211 is screened partially across clean soils so high levels of oxygen in the soil gas is not surprising (Table 2.1). This survey confirmed that aerobic fuel biodegradation is occurring in contaminated soils, and that bioventing may be a feasible remediation technology at this site.

2.2 Building 457 Area

2.2.1 Site Location and History

Building 457 is located west of Spill Site No. 1 (Figure 2.1), and was formerly used as a fuel cell maintenance and repair shop (US Air Force, 1995). A 20,074-gallon steel UST used to store fuel oil, located at the northwest corner Building 457, was removed in August 1994 (US Air Force, 1995). The site layout is shown in Figure 2.3. Analytical results of soil samples taken from the sidewalls of the excavation pit indicated that all contaminated soil had not been removed (US Air Force, 1995). The excavated soil is being landfarmed on base. The excavation was backfilled with treated soil from the landfarm (Looney, 1996).

UST Area 410 is located approximately 200 feet southwest of Building 457, near the above-mentioned tank site. In the 1940s, 12 25,000-gallon USTs were installed and used for aviation fuel storage until the mid-1950s (Figure 2.3). Four of the tanks were removed in 1988, and the other eight were removed in November, 1995 (Looney,

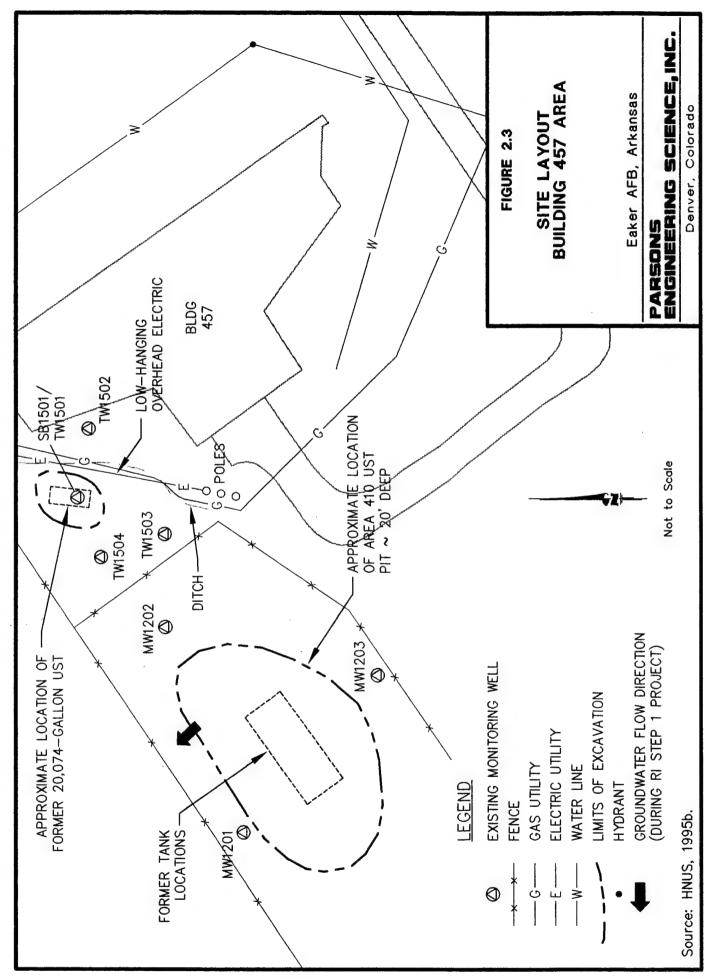
TABLE 2.1 INITIAL SOIL GAS CHEMISTRY SPILL SITE NO. 1 EAKER AFB, ARKANSAS

Sample Location	Screen Depth (feet bgs) ^{a/}	O ₂ (%)	CO ₂ (%)	Field TVH (ppmv) ^{b/}
MW201	7-22	9.1	8.0	1,000
MW202	6.6-21.6	8.5	4.3	4,800
MW203	6-21	4.2	11.2	>10,000
MW204	NA ^{c/}	19.8	1.6	150
MW207	11.6-21.6	0.0	12.0	6,000
MW211	9-19	18.9	2.3	>10,000

a/ bgs = below ground surface.

Total volatile hydrocarbon field screening results reported in parts per million, volume per volume.

NA = not available.



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1996). Approximately 4,500 cubic yards of contaminated soil was excavated and is being treated at a Base soil landfarm; however, some smear zone contamination above state soil cleanup levels for TPH is anticipated. The excavation pit was backfilled with treated soil from the landfarm (Looney, 1996).

2.2.2 Site Geology and Hydrology

Subsurface soils at the Building 457 Area are similar to those at Spill Site No. 1; primarily consisting of silty clay materials with interbedded sandy lenses to a depth of 12 feet bgs. Groundwater is encountered at a depth of approximately 3.5 to 9.5 feet bgs, and flows to the northwest or southwest, depending on seasonal variations (HNUS, 1995a).

2.2.3 Site Contaminants

The primary contaminants near Building 457 are petroleum hydrocarbons, which have been detected in the soils and groundwater. The sources of vadose zone contamination near Building 457 and Area 410 were UST leaks at the respective areas. The highest concentrations of organics at the Building 457 UST site were found in samples collected at the south and east excavation walls. TPH were detected at concentrations of 1,400 mg/kg and 4,700 mg/kg at a depth of 12 feet bgs at the east and south locations, respectively. TPH analytical results from samples from the north and west excavation walls were non-detects (US Air Force, 1995). Based on soil headspace readings and analytical results from the monitoring wells, it appears that vadose zone soil contamination is confined to the area immediately adjacent to the tank excavation.

Parsons ES conducted an initial soil gas survey of existing monitoring wells at the Building 457 tank site. Table 2.2 presents the results of the soil gas survey. Low oxygen concentrations measured at monitoring wells TW1501 and TW1503 (Figure 2.3) indicate that without the benefit of air injection, natural biodegradation of fuel compounds may be limited. The majority of petroleum hydrocarbon contamination at the site appears to be in the smear zone.

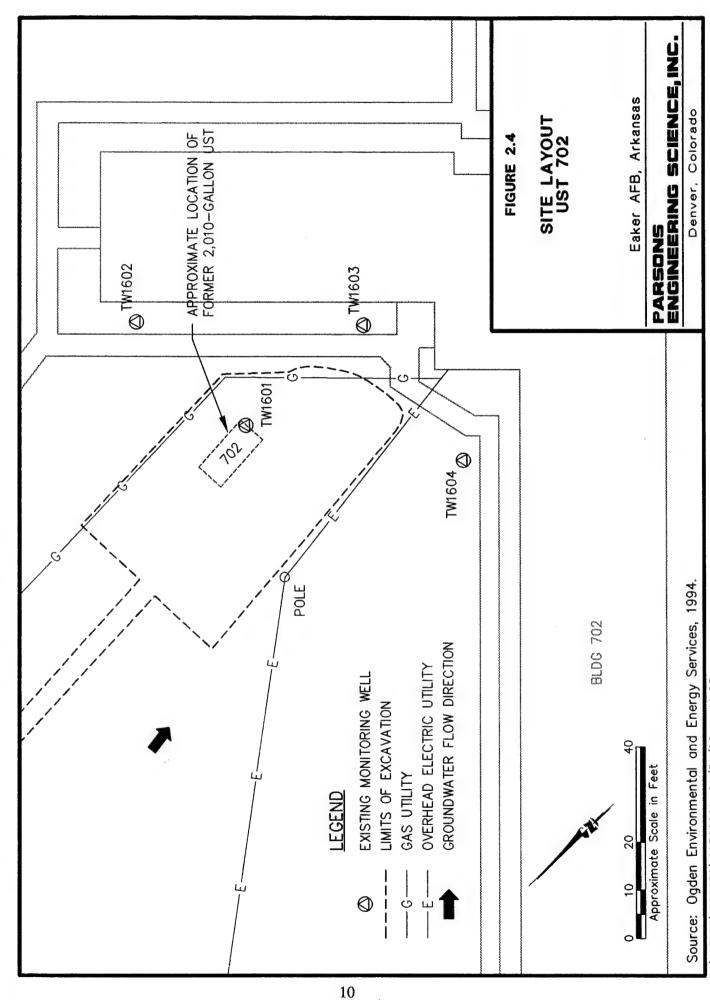
Most of the contaminated soils at the 410 Area have been excavated. A soil gas survey conducted in 1995 for HNUS indicates that soils upgradient from the excavation are relatively clean; however, because the survey did not encompass the downgradient (northwest) side, site conditions are not fully characterized. During bioventing activities at the Building 457 UST site, a soil gas survey will be conducted at monitoring wells MW1201, MW1202, and MW1203 at the 410 Area (Figure 2.3) to determine if oxygen levels are sufficient to sustain microbial activity. Should 410 Area site conditions require bioventing, the pilot test system at Building 457 UST site may be expanded to include the 410 Area.

TABLE 2.2 INITIAL SOIL GAS CHEMISTRY BUILDING 457 AREA EAKER AFB, ARKANSAS

Sample Location	Screen Depth (feet bgs) a/	O ₂ (%)	CO ₂ (%)	Field TVH (ppmv) ^{b/}
TW1501	6-16	3.0	10.3	70
TW1502	8-18	9.5	7.3	94
TW1503	5.5-15.5	2.0	7.1	960
TW1504	5.5-15.5	7.9	5.9	140

bgs = below ground surface.

Total volatile hydrocarbon field screening results reported in parts per million, volume per volume.



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2.3 UST 702

2.3.1 Site Location and History

Former UST 702 was located adjacent to Building 702 in the west central portion of the Base (Figure 2.1). The site layout is shown in Figure 2.4. The former 2,010-gallon tank, used to store fuel oil that was used for heating Building 702, was removed in June 1994. Although the tank was over excavated, tank removal soil sampling results confirmed that not all contaminated soil had been removed from the site (US Air Force, 1995). The excavation has since been backfilled with treated soil from the onsite landfarm (Looney, 1996). The site is currently vacant and inactive.

2.3.2 Site Geology and Hydrology

Subsurface soils near former UST 702 primarily consist of silt and sand from ground surface to 12 feet bgs, and silty clay materials at a depth of 12 to 16 feet bgs. Groundwater was encountered at a depth of approximately 8 to 9 feet bgs during September 1995 (HNUS, 1995b).

2.3.3 Site Contaminants

The primary contaminants at this site are petroleum hydrocarbons, which have been detected in the soils. Soil samples collected during the tank removal activities indicate that the highest concentrations of petroleum hydrocarbons in soils were detected at the southern edge of the tank excavation. TPH were detected at the south wall (12,000 mg/kg), east wall (6,100 mg/kg), and west wall (3,100 mg/kg) at a depth of 17 feet bgs (US Air Force, 1995). The majority of petroleum hydrocarbon contamination at the site appears to be in the smear zone. Soil sample analytical results from samples collected during the monitoring well installation, indicate that the extent of contamination is limited to the area adjacent to the former tank excavation (HNUS, 1995b). No BTEX samples have been collected to date.

Parsons ES conducted an initial soil gas survey of existing monitoring wells at the UST 702 site. Table 2.3 presents the results of the soil gas survey. Low oxygen concentrations measured at monitoring well TW1601 (Figure 2.4) indicate that without the benefit of air injection, natural biodegradation of fuel hydrocarbons may be limited.

3.0 PILOT TEST ACTIVITIES

The purpose of this section is to describe the pilot test activities proposed for Spill Site No. 1, Building 457 Area, and UST 702. The proposed locations and construction details for the VWs and vapor MPs are discussed. Where appropriate, an existing monitoring well may be used as a VW. Existing monitoring wells that are installed in clean soils will be used as background MPs. Soil and soil gas sampling procedures and the blower configuration that will be used to inject air (oxygen) into contaminated soils also are discussed in this section. Finally, a brief description of the pilot test procedures is provided.

TABLE 2.3 INITIAL SOIL GAS CHEMISTRY UST 702 EAKER AFB, ARKANSAS

Screen Depth (feet bgs) ^{a/}	O ₂ (%)	CO ₂ (%)	Field TVH (ppmv) ^{b/}
6-16	1.1	11.0	88
6-16	20.7	0.4	40
6-16	20.8	0.05	0
6-16	20.8	0.05	3
	Depth (feet bgs) a/ 6-16 6-16 6-16	Depth (%) (feet bgs) a/ 6-16 1.1 6-16 20.7 6-16 20.8	Depth (%) (%) (feet bgs) a/ 6-16 1.1 11.0 6-16 20.7 0.4 6-16 20.8 0.05

bgs = below ground surface.

Total volatile hydrocarbon field screening results reported in parts per million, volume per volume.

The bioventing technology is intended to remediate contamination only in the unsaturated zone. Therefore, pilot test activities will be confined mainly to unsaturated soils. Prior to installation of the VWs and vapor MPs at each site, the anticipated VW and MP borehole locations will be presampled with a Geoprobe truck-mounted The locations will be sampled continuously from hydraulic direct-push rig. approximately 3 feet bgs to 1 foot below the groundwater surface and screened for VOCs with a PID and a THVA. Before abandoning the Geoprobe boreholes, the site engineer will identify the boreholes to be used as vapor MPs. Typically, multipledepth vapor MPs are preferred; however, considering the shallow groundwater table at Eaker AFB, only single-depth vapor MPs may be installed in most cases. The MPs will be installed in select Geoprobe boreholes, within the most contaminated unsaturated interval as indicated by field screening for VOCs. If subsequent soil gas sampling of the newly installed MPs at Building 457 Area and UST 702 reveals sufficient oxygen concentrations (>15%) in native soils adjacent to the excavation, then a VW will be installed in the center of the tank excavation. If significant vadose zone petroleum contamination is encountered in native soils adjacent to the excavation, conceptually, a vent well(s) will be installed approximately 10 to 15 feet from the excavation. Additionally, selected existing monitoring wells that are not used as VWs will be used as vapor MPs. No dewatering will take place during the pilot tests.

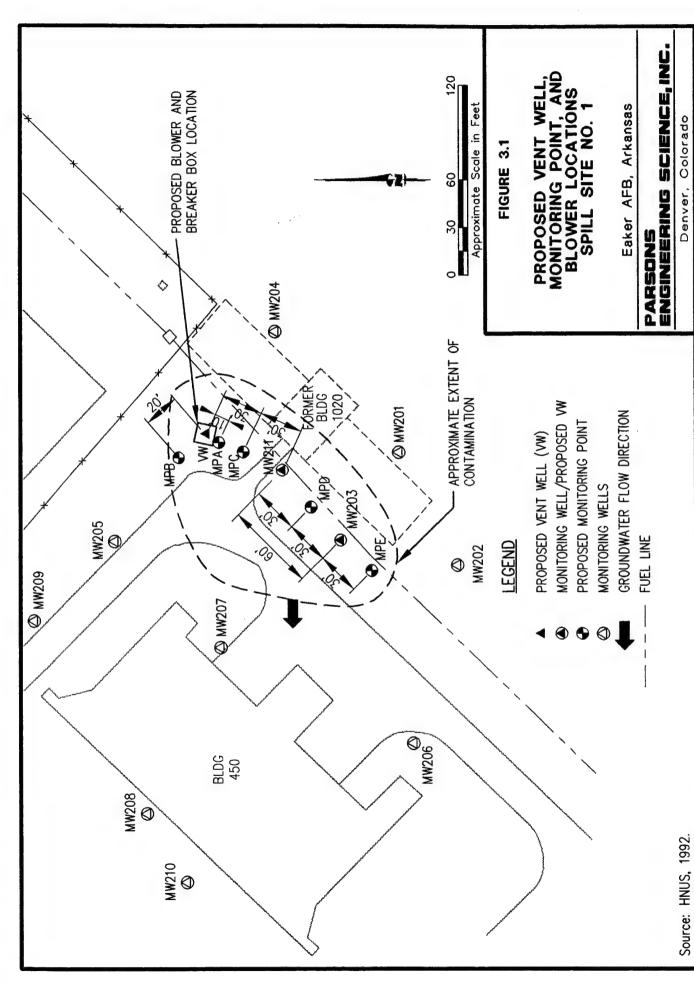
3.1 Test Design for Spill Site No. 1

A general description of criteria for siting VWs and vapor MPs is included in the protocol document (Hinchee et al., 1992). Figure 3.1 illustrates the proposed locations of the three VWs (including two existing monitoring wells to be used as VWs) and five MPs at Spill Site No.1. Review of the construction details of the existing groundwater monitoring wells (Appendix A) indicated that monitoring wells MW203 and MW211 are suitable for use as VWs or as vapor MPs. Conceptually, it is anticipated that air will be injected into monitoring wells MW203 and MW211, and the one proposed additional VW. The final location of the additional VW may vary slightly from the proposed location shown on Figure 3.1 if significant fuel contamination is not observed in the Geoprobe borehole. Soils in this area are TPH-contaminated and oxygendepleted (< 2 percent), and biological activity should, therefore, be stimulated by oxygen-rich soil gas ventilation during pilot test operations.

Because of the low-permeability soils in fuel-contaminated regions, fine-grained soils near the surface (which reduce airflow to the surface), and Parsons ES's experience with similar soil types, the potential radius of venting influence around the VWs is expected to be 30 feet. Five vapor MPs (MPA, MPB, MPC, MPD, and MPE) will be located within a 30-foot radius of the VWs (Figure 3.1).

3.1.1 Vent Well Installation

The additional VW will be constructed of 4-inch-diameter Schedule 40 polyvinyl chloride (PVC) casing, with an estimated 10-foot interval of 0.04-inch slotted screen set at 5 to 15 feet bgs. Flush-threaded PVC casing and screen with no organic solvents or glues will be used. The filter pack will be clean, well-rounded silica sand with a 6-9 grain size, which will be placed in the annular space to 1 foot above the screened



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interval. A 2.5-foot-thick bentonite seal will be placed directly over the filter pack to produce an air-tight seal above the screened interval. The bentonite seal, consisting of granular bentonite, will be placed in 6-inch layers, with each layer hydrated in place with potable water prior to the addition of subsequent layers. A complete seal is critical to prevent injected air from short-circuiting to the surface during the bioventing test. The VW annulus will be filled with a cement/bentonite slurry to the ground surface. The blower will be placed directly over the VW, so a protective well box will not be necessary. Figure 3.2 illustrates the proposed additional VW construction detail for this site.

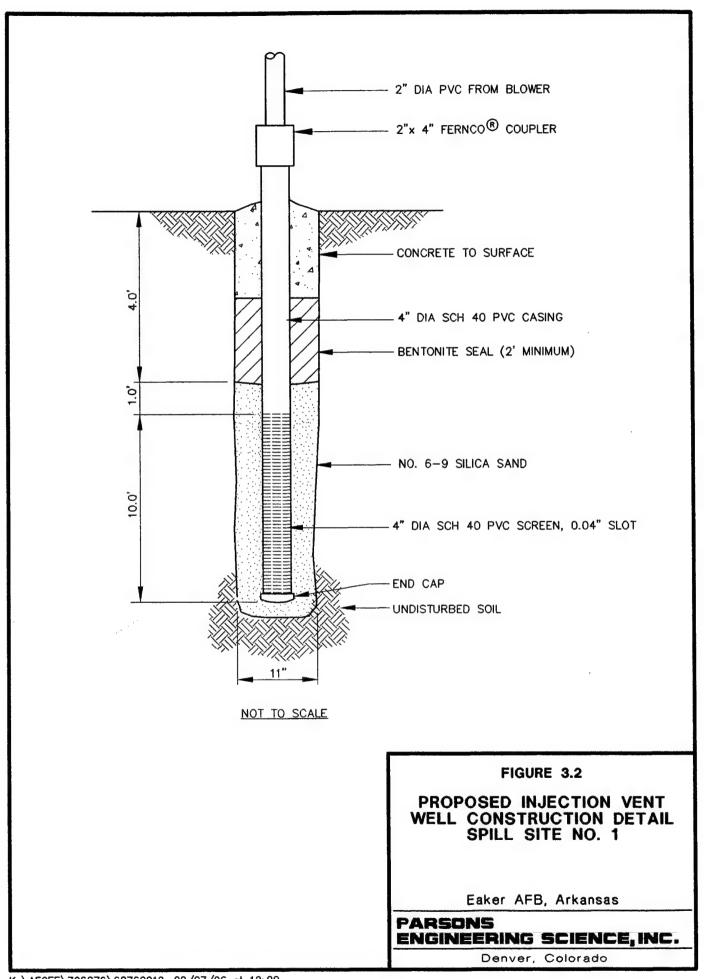
3.1.2 Monitoring Point Installations

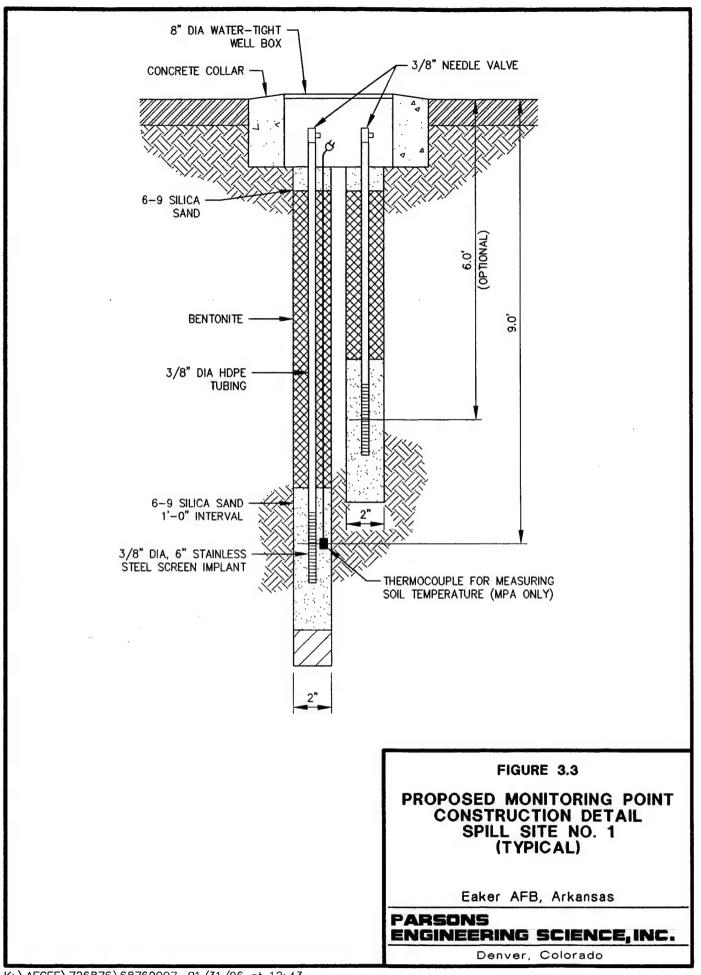
A typical multi-depth vapor MP installation for this site is shown in Figure 3.3. Soil gas oxygen, carbon dioxide, and total volatile hydrocarbon (TVH) concentrations will be monitored at depths of approximately 6 feet and/or 9 feet bgs at each location. Soil temperature will be monitored using a thermocouple installed at the deep screened interval of MPA. Multi-depth monitoring will confirm that the entire soil profile is receiving oxygen, and fuel biodegradation rates can be measured at the two depths. If contamination is limited to the smear zone, only one MP interval will be installed at each location in the contaminated interval.

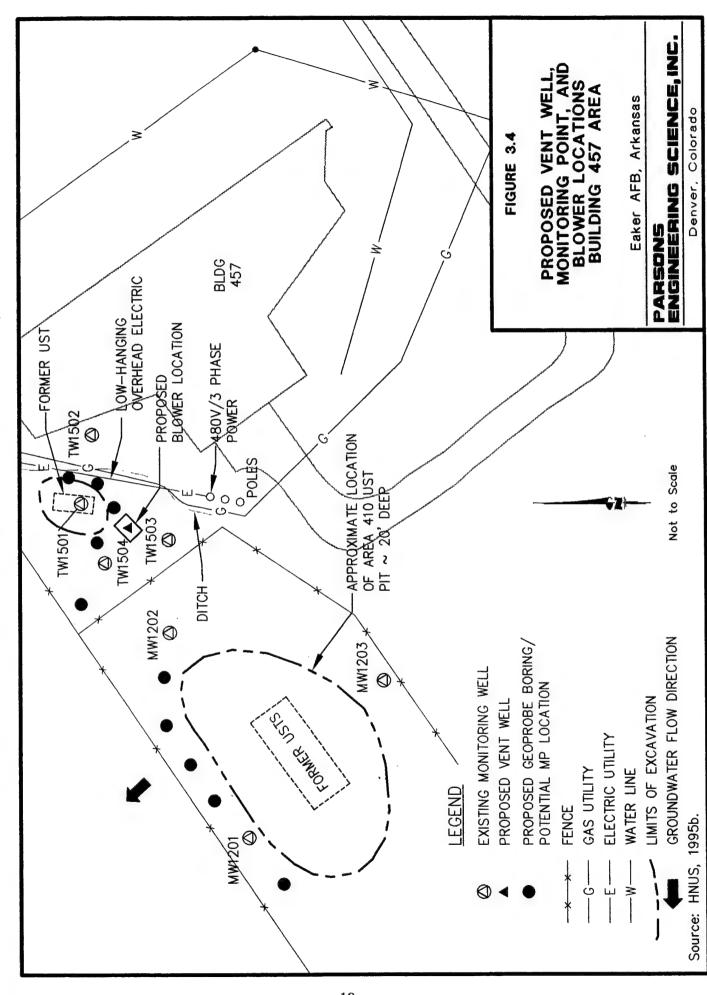
Each MP will be constructed with one or two vapor probes placed within a 6-9 silica sand pack, separated by bentonite seals. Each vapor probe, constructed of 6-inch-long, 0.25-inch, outside-diameter (OD) stainless steel screen implant attached to 0.5-inch-OD, high density polyethylene (HDPE) tubing that extends to the ground surface. The top of each 0.5-inch HDPE riser will be completed with a 3/8-inch needle valve. The screens will be placed within a 1-foot layer of 6-9 silica sand. The annular space between the screened MP intervals and the ground surface will be sealed with bentonite to isolate the monitoring interval. The bentonite seals will consist of granular bentonite hydrated in place. The bentonite will be placed in 6-inch layers and hydrated with potable water prior to placement of subsequent layers to ensure complete saturation of the bentonite. Additional details on VW and MP construction are presented in Section 4 of the protocol document.

3.2 Test Design for Building 457 Area

The former UST area immediately west of Building 457 is the proposed bioventing pilot test area (Figure 2.2); however, if significant vadose zone contamination (to a depth of approximately 9.5 feet bgs) is discovered in 410 Area during Geoprobe investigative drilling and soil gas sampling, an additional VW and MPs may be installed, and the Building 457 Area blower system may be expanded to treat the 410 Area. Figure 3.4 illustrates the proposed VW location to be drilled at Building 457 Area, and proposed Geoprobe locations to be screened for siting prospective locations for MPs or additional VWs. Review of the construction details of the existing groundwater monitoring wells (Appendix A) indicates that monitoring wells MW1201 and MW1202 are suitable for use as VWs, or as additional vapor MPs. The final location of the proposed VW to be installed near Building 457 may vary slightly from







K:\AFCEE\726876\68760005, 02/08/96 at 15:37

the proposed location shown on Figure 3.4 if significant fuel contamination is not observed in the Geoprobe borehole. If contamination is observed to extend no more than approximately 7 feet outside the former excavation, then the VW will be installed in the center of the excavation.

Because of the low-permeability soils in fuel-contaminated regions, fine-grained soils near the surface (which reduce airflow to the surface), and Parsons ES's experience with similar soil types, the potential radius of venting influence around the VW is expected to be 30 feet. Conceptually, up to two VWs and five MPs may be installed at Building 457 Area; at least two MPs will be located within a 30-foot radius of the proposed VW (Figure 3.4).

3.2.1 Vent Well Installation

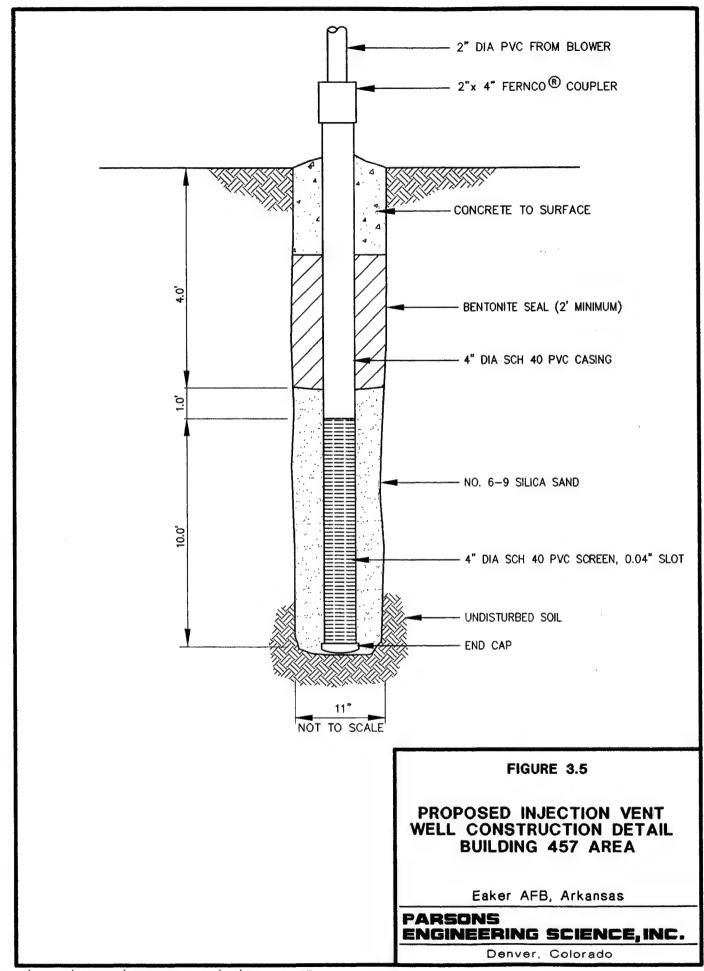
The additional VW(s) will be constructed of 4-inch-diameter Schedule 40 PVC with an estimated 10-foot interval of 0.04-inch slotted screen set at 4 to 14 feet bgs. Flush-threaded PVC casing and screen with no organic solvents or glues will be used. The filter pack will be clean, well-rounded silica sand with a 6-9 grain size which will be placed in the annular space to 1 foot above the screened interval. A 3-foot-thick bentonite seal will be placed directly over the filter pack to produce an air-tight seal above the screened interval. The bentonite seal, consisting of granular bentonite, will be placed in 6-inch layers, with each layer hydrated in place with potable water prior to the addition of subsequent layers. A complete seal is critical to prevent injected air from short-circuiting to the surface during the bioventing test. A cement/bentonite slurry will be placed above the seal to the ground surface. The blower shed will be placed over the VW, so a protective well box will not be necessary. Figure 3.5 illustrates the proposed VW construction detail for this site.

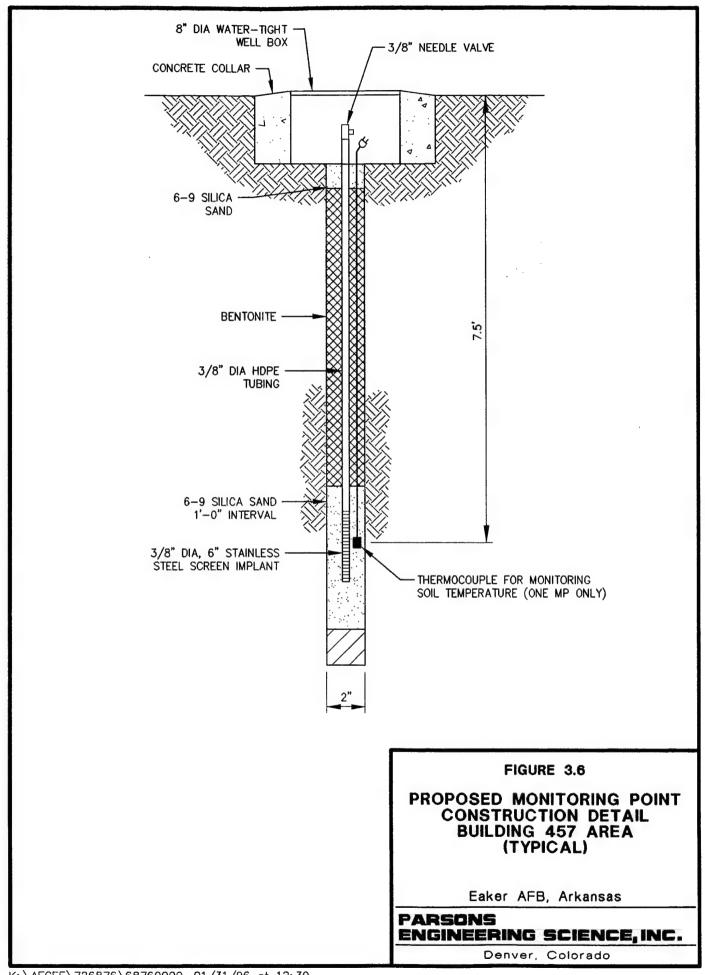
3.2.2 Monitoring Point Installations

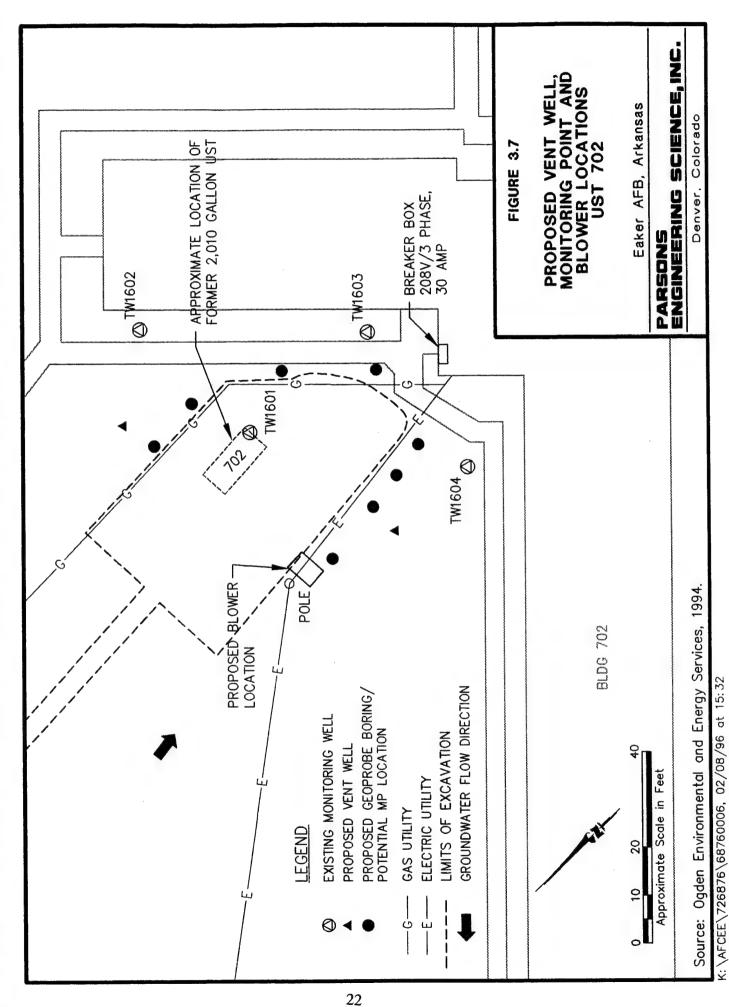
A typical multi-depth vapor MP installation for this site is shown in Figure 3.6. It is anticipated that soil gas oxygen, carbon dioxide, and TVH concentrations will be monitored only at a single depth interval of approximately 7.5 feet bgs at each location. Soil temperature will be monitored using a thermocouple installed at one of the MPs. Geoprobe soil samples, collected in clear polybutyrate liners, will be visually inspected and screened for VOCs. A vapor probe will be placed only in those soil intervals with apparent petroleum contamination, where oxygen levels are expected to be depleted. Each MP will be constructed as described in Section 3.1.2.

3.3 Test Design for UST 702

Figure 3.7 illustrates the proposed VWs and MPs to be installed at UST 702. Review of the construction details of the existing groundwater monitoring wells (Appendix A) indicated that monitoring wells TW1601, TW1602, and TW1603 are suitable for use as VWs, or as additional vapor MPs. The final locations of the two additional proposed VWs and MPs may vary slightly from the proposed locations shown on Figure 3.7 if significant fuel contamination is not observed in the predrilled Geoprobe borings. Soils in this area are TPH-contaminated and expected to be







oxygen-depleted (< 2%), and biological activity should therefore be stimulated by oxygen-rich soil gas ventilation during pilot test operations.

Because of the low-permeability soils in fuel-contaminated regions, fine-grained soils near the surface (which reduce airflow to the surface), and Parsons ES's experience with similar soil types, the potential radius of venting influence around the VWs is expected to be 30 feet. Four MPs will be located within a 30-foot radius of the VWs (Figure 3.7).

3.3.1 Vent Well Installation

The additional VW(s) will be constructed of 4-inch-diameter Schedule 40 PVC with an estimated 10-foot interval of 0.04-inch slotted screen set at 5 to 15 feet bgs. Flush-threaded PVC casing and screen with no organic solvents or glues will be used. The filter pack will be clean, well-rounded silica sand with a 6-9 grain size which will be placed in the annular space to 1 foot above the screened interval. A 2.5-foot-thick bentonite seal will be placed directly over the filter pack to produce an air-tight seal above the screened interval. The bentonite seal, consisting of granular bentonite, will be placed in 6-inch layers, with each layer hydrated in place with potable water prior to the addition of subsequent layers. A complete seal is critical to prevent injected air from short-circuiting to the surface during the bioventing test. The VW surface completion will consist of 12-inch diameter, flush-mounted, protective well box emplaced in a concrete pad. Figure 3.8 illustrates the proposed VW construction detail for this site.

3.3.2 Monitoring Point Installations

A typical multi-depth vapor MP installation for this site is shown in Figure 3.9. It is anticipated that soil gas oxygen, carbon dioxide, and TVH concentrations will be monitored only at a single depth interval of approximately 8 feet bgs at each MP location. Soil temperature will be monitored using thermocouples installed at one of the MPs. Geoprobe soil samples, collected in clear polybutyrate liners, will be visually inspected and screened for VOCs. A vapor probe will be placed only in those intervals with apparent petroleum contamination, where oxygen levels are expected to be depleted. Each MP will be constructed as described in Section 3.1.2.

3.4 Soil and Soil Gas Sampling

3.4.1 Soil Samples

Six soil samples will be collected from each pilot test area during installation of VWs and MPs and submitted to an analytical laboratory for analysis. Sampling procedures will follow those outlined in the protocol document. A THVA will be used during drilling to screen split-spoon samples for intervals of significant fuel contamination. Based on field screening results, six samples from the most highly contaminated locations at each site will be analyzed for total extractable petroleum hydrocarbons (TVPH) or total volatile petroleum hydrocarbons (TVPH) by EPA Method 8015 and BTEX by EPA Method 8020. Three of these samples from each site

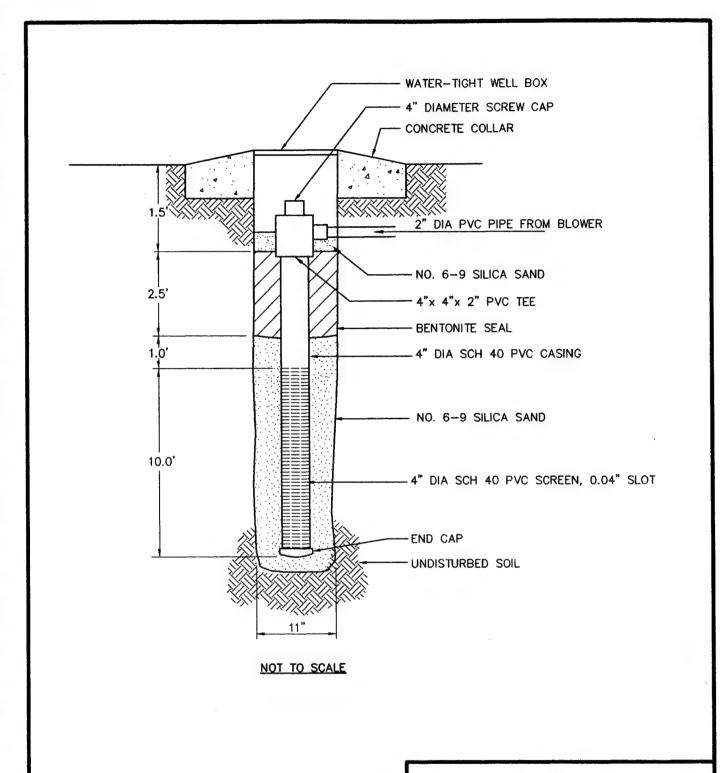


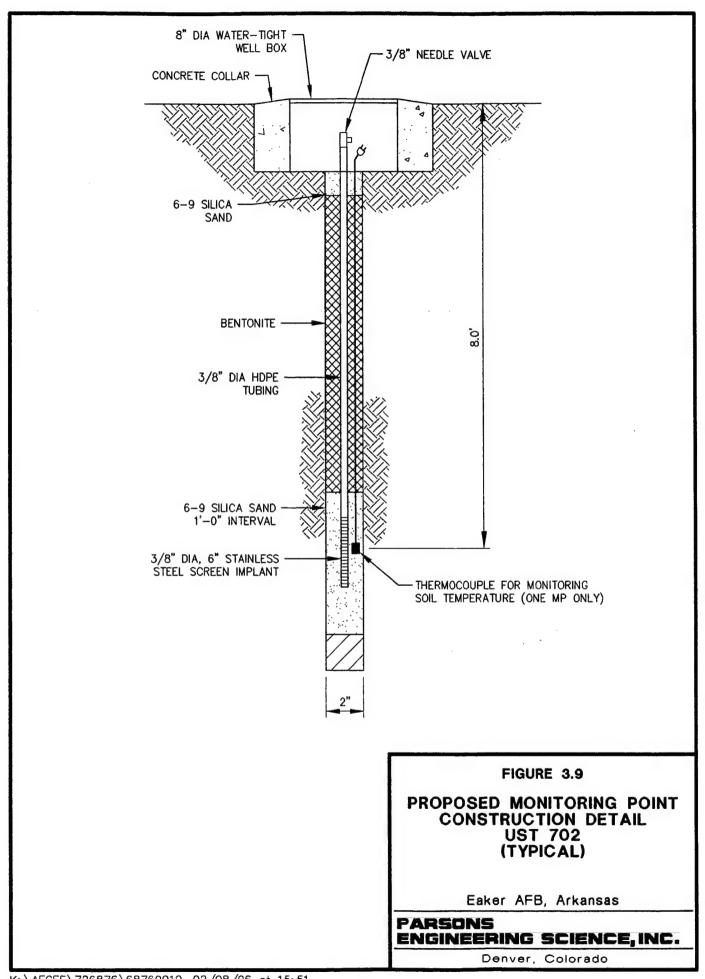
FIGURE 3.8

PROPOSED INJECTION VENT WELL CONSTRUCTION DETAIL UST 702 (TYPICAL)

Eaker AFB, Arkansas

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado



also will be analyzed for soil moisture, pH, particle size, alkalinity, total iron, and nutrients. One background sample, collected from a Geoprobe boring drilled adjacent to the selected background monitoring well, will be analyzed for total Kjeldahl nitrogen (TKN).

Samples for TEPH, TVPH, and BTEX analysis will be collected from Geoprobe boreholes. Soil samples collected in the polybutyrate liners for TPH, BTEX, and physical parameter analyses will be immediately trimmed, and the ends will be sealed with aluminum foil or Teflon® fabric held in place by plastic caps. Soil samples will be labeled following the nomenclature specified in the protocol document (Section 5), wrapped in plastic, placed in a cooler with ice, and maintained at a temperature of approximately 4 degrees centigrade (°C) for shipment. A chain-of-custody form will be completed, and the cooler will be shipped to an AFCEE-approved laboratory for analysis.

3.4.2 Soil Gas Samples

At each site, soil gas samples will be collected from nearby monitoring wells, VWs, and MPs, and field screened for oxygen, carbon dioxide, and TVH. Soil gas samples from six of the most contaminated locations at each site will be collected in SUMMA® canisters in accordance with the Bioventing Field Sampling Plan (ES, 1992) and submitted for laboratory analysis. These soil gas samples will be used to predict potential air emissions, to determine the reduction in BTEX and TVH during the 1-year test, and to detect any migration of these vapors from the source area.

Soil gas sample canisters will be placed in a small cooler and packed with foam pellets to prevent excessive movement during shipment. Samples will be sent at ambient temperature to prevent condensation of hydrocarbons. A chain-of-custody form will be completed, and the cooler will be shipped to the Air Toxics, Inc. laboratory in Folsom, California for analysis.

3.5 Blower System

A 3-horsepower positive displacement blower capable of injecting air over a wide range of flow rates and pressures will be used to conduct the initial air permeability tests at each site. Figure 3.10 presents a schematic of a typical air injection system used for pilot testing. The maximum power requirement anticipated for these pilot tests is 230-volt, three-phase, 30-amp service. Electrical power will be obtained from a nearby power pole located adjacent to each proposed blower location. An electrical distribution panel, shut-off switch, and electrical outlets will be installed on the existing pole or on the blower shed. Installation of electrical equipment and necessary wiring will be provided by an electrical subcontractor hired by Parsons ES.

3.6 In Situ Respiration Test

The objective of the *in situ* respiration test is to determine the rate at which soil bacteria degrade petroleum hydrocarbons. Respiration tests will be performed at selected MPs where bacterial biodegradation of hydrocarbons is indicated by low oxygen levels and elevated carbon dioxide concentrations in the soil gas. Using 1cubic-foot-per-minute (cfm) pumps, air will be injected into approximately four MP depth intervals containing low levels (< 2 %) of oxygen at each site. Monitoring wells with low oxygen levels may also be tested. A 20-hour air injection period will be used to oxygenate local contaminated soils. At the end of the 20-hour air injection period, the air supply will be cut off, and oxygen, carbon dioxide, and TVH concentrations will be monitored during the following 48 to 72 hours. The decline in oxygen and increase in carbon dioxide concentrations over time will be used to estimate rates of bacterial degradation of fuel residuals. Helium will also be injected into the selected MP screened intervals to determine the effectiveness of the bentonite seals. Additional details on in situ respiration testing are found in Section 5.7 of the protocol document (Hinchee et al., 1992).

3.7 Air Permeability Test

The objective of the air permeability testing is to determine the extent of the subsurface that can be oxygenated using one air injection VW. Prior to initiating the test, baseline concentrations of oxygen, carbon dioxide, and TVH will be measured in soil gas from the VW and each MP screened interval.

Air will be injected into one of the newly installed VWs at each site using a positive displacement blower unit, and pressure response will be measured at each existing monitoring well within 50 feet of the injection well and each newly installed MP with differential pressure gauges to determine the region influenced by the unit. Oxygen will also be monitored in the MPs to ascertain whether oxygen levels in the soil increase as the result of air injection. One air permeability test lasting 4 to 24 hours will be performed at each site.

Discrete vapor MPs provide a better indicator as to pressure response in different soil profiles, so testing information gathered from the monitoring wells will be used primarily to determine the radius of oxygen influence. At least two MPs (at varying distances) will be installed prior to permeability testing. Initial soil gas sampling will be performed prior to air injection.

3.8 Installation of 1-Year Pilot Test Bioventing System

Extended, 1-year pilot-scale bioventing systems will also be installed at Spill Site No. 1, Building 457 Area, and UST 702. The systems will be designed based upon the results of the initial respiration and permeability tests. However, it is anticipated that the extended test blowers will have flow rates in the range of 25 to 50 scfm and will not exceed 4 horsepower. The blowers will each be housed in a small, lockable,

prefabricated shed to provide protection from the weather. At each site, a licensed electrical subcontractor to Parsons ES will provide a 208-volt, three-phase, 30-amp service. The blower units will be explosion-proof, and electrical wiring will be installed in accordance with the National Electric Code (NEC) and Base codes for locations with potentially explosive atmospheres.

The systems will be in operation for 1 year. Bimonthly system checks will be performed by Eaker AFB personnel. If required, major maintenance of the blower units will be performed by Parsons ES personnel. Detailed blower system information and a maintenance schedule will be included in the operation and maintenance (O&M) manual that will be provided to the AFBCA. After the systems have operated for 1 year, Parsons ES personnel will return to the sites to conduct *in situ* respiration testing and soil gas sampling to determine the long-term effectiveness of the systems.

4.0 HANDLING OF INVESTIGATION-DERIVED WASTE

All soil cuttings will be hauled to a nearby Base soil landfarm designated by the Base. Few cuttings will be generated from the VW boreholes; only about 4 cubic yards. Drill cuttings will be disposed of in accordance with the current procedures for ongoing remedial investigations at Eaker AFB.

5.0 EXCEPTIONS TO PROTOCOL PROCEDURES

The procedures that will be used to measure the air permeability of the soil and *in situ* respiration rates are described in Sections 4 and 5, respectively, of the protocol document. No exceptions to the protocol are anticipated.

6.0 BASE SUPPORT REQUIREMENTS

The following Base support is needed prior to the arrival of the drilling subcontractor and the Parsons ES pilot test team:

Assistance in obtaining drilling and digging permits.

During initial testing, the following Base support is needed:

- Twelve square feet of desk space and a telephone in a building located as close to the site as practical.
- The use of a facsimile machine for transmitting 15 to 20 pages of test results.
- A decontamination area where the driller can clean augers between borings.
- A potable water supply for well construction and decontamination activities.

During the 1-year extended pilot test, Base or AFBCA personnel will be required to perform the following activities:

- Check the blower system once per every two weeks to ensure that it is operating, and to record the air injection pressure and other parameters. Parsons ES personnel will provide a brief training session on this procedure.
- If the blower stops working, notify Mr. Dave Teets or Mr. John Ratz of Parsons ES at (303) 831-8100; or Lt Maryann Jenner of AFCEE at (210) 536-5688, or Mr. Jerry Hansen of AFCEE at (210) 536-4353.

7.0 PROJECT SCHEDULE

The following schedule is contingent upon approval of this pilot test work plan and completion of base support requirements.

Event	<u>Date</u>
Draft Test Work Plan to AFCEE/Eaker AFB	9 February 1996
Field Mobilization	16 March 1996
Preconstruction Meeting	18 March 1996 (10AM)
Begin Initial Pilot Tests	18 March 1996
Postconstruction Meeting	4 April 1996 (10AM)
Demobilization	5 April 1996
Letter Results Report	17 May 1996
Final Respiration Test and Soil Gas Sampling	March 1997

8.0 POINTS OF CONTACT

Mr. Thomas Zachary AFBCA/OL-J P.O. Box 9400 Gosnell, AR 72319-0400 COM (501) 532-6550 FAX (501) 532-8738

Lt Maryann Jenner or Jerry Hansen AFCEE/ERT 8001 Arnold Drive Brooks AFB, TX 78235-5000 (210) 536-5688, (210) 536-4353 Fax (210) 536-4330 Mr. David Teets and Mr. John Ratz Parsons Engineering Science, Inc. 1700 Broadway, Suite 900 Denver, CO 80290 (303) 831-8100 Fax (303) 831-8208

9.0 REFERENCES

- Engineering-Science, Inc. 1992. Field Sampling Plan for AFCEE Bioventing. January.
- Haliburton NUS Environmental Corporation (HNUS), 1992. Technical Memorandum (Step 2) for the Remdial Investigation/Feasibility Study.
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- HNUS, 1995b. Information received via fax on December 8.
- Hinchee, R.E., S.K. Ong, R.N. Miller, D.C. Downey, and R. Frendt. 1992. Test Plan and Technical Protocol for a Field Treatability Test for Bioventing. May.
- Looney, Randal J. 1996. Personal communication. Phone conversation between Randal J. Looney (Eaker AFBCA) and David B. Teets (Parsons ES) regarding site history of 410 Area, February 1, 1996.
- Ogden Environmental and Energy Systems, 1994. Tank removal report drawing.
- Parsons Engineering Science, Inc. 1995. Program Health and Safety Plan for Extended Bioventing. Prepared for Air Force Center for Environmental Excellence, Environmental Restoration Technology, USAF Contract F41624-92-D-8036, Delivery Order 17. April.
- US Air Force, 1994. Statement of Work, Title 1 A-E Services for Bioventing Monitoring/Full-Scale Design. Contract No. F41624-92-D-8036, Delivery Order 17. May 26
- US Air Force, 1995. Unpublished site history and data, Eaker AFB, Arkansas.

APPENDIX A

MONITORING WELL AS-BUILT CONSTRUCTION DIAGRAMS

FIELD WELL	FORM		CHRISTY BOX			
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10 FEET OF 2 INCH PVC SLOTTED SCREEN	BOTTOM OF BOREHOLE
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TOTAL WATER	REMOVED	то					SEAL OR SEAL OR SEAL OR
DESCRIPTION	LOPMENT:		GALLONS				SEAL
OF TURBIDITY AT END OF DEVELOPMENT	CLEA!		SLIGHTLY CLO	UDY			'O leer BENTONITE PELLET
ODOROF		TURBID	VERY MUDDY				SEAL (cet
WATER:	Перения						MORIE 20140
DISCHARGED TO:	□GROUND S □STORM SEI	_	TANK TRUCK STORAGE TANK				SAND PACK
DEPTH TO WATE	DRUMS	_	OTHER				4 10 16 feet
AFTER DEVELO	PMENT:		FEET	,			SLOTTED (0.010
MATERIALS U	SED						inch: SCREEN (c to 1 6 feet
4.5 SAC	CKS OF MERT	F. E. CO P. 1	CON'			-	
SAC	CKS OF		CEM	ID			SCHEDULE 40 PVC BLANK SULT TRAP
GAI	LLONS OF GROU	TUSED	CEM	ENI			toleet
SAC	KS OF POWDERS	D BENTONIT	E		Ł	 →	BOTTOM WELL CAP
SO POU	INDS OF BENTON	UTE DEL 1 570	1 Ruck =				16 leet
FEE	TOFINCH	PVC BLANK	'ASING				HOLE CLEANED OUT TO
FEE	T OF INCH	PVC SLOTTED	SCREEN	، شيع	L		BOTTOM OF BOREHOLE
	. 1				1.2		16 feet
YAR	D" CEMENT-SAN	D (REDI-MIX)	ORDERED	:	NOT TO S	CALE	
YAR	CEMENT-SAN	4			ADDITIO	NAL IN	IFORMATION:
NAME	CH OZEDS (C)	NO DAE2					1c = 6BAGS
WELL COVER USE	D: DLOCKING	STEEL COVE					
	U CHRISTY	BOX					
	LE OTHER	TEMP	WELL				



FIELD WELL COMPLETION FORM	CHRISTY BOX
100 0 100	LOCKING STEEL COVER
HAME: BAFB JP-1 SITE	6 INCH DIAMETER
NUMBER: L579 PROJECT J Nelson	CASING
LOGGEO 2. Yelkin BY: J. LPW.S	tofeet
MW-201 128	74 INCH DIAMETER
COMPANY: A.W. Pool	
EQUIPMENT: P74 INCH HOLLOW STEM AUGER G. Pec	BENTONITE-CEMENT
INCH ROTARY WASH DRILLED:	J BSACK CEMENTSAND
GALLONS OF WATER	101991
METHOD OF DECONTAMINATION	2.46 TOP OF CASING AT
PRIOR TO DRILLING: precisive steam clean	# 3.0 FEET ABOVE
DEVELOPMENT	SECON GROUND LEVEL
DEVELOPMENT: Bailine	7/4 INCH DIAMETER
DEVELOPMENT BEGAN DATE: TIME:	0 to 23, 1ser
GPM FROM TO	INCH DIAMETER
GPM FROM TO	BLANK CASING
TIME: DATE:	+ 3.0 to 7.0 feet
TIELD: TIME: DATE:	SEAL OR
TOTAL WATER REMOVED	8-SACK CEMENT-SAND
	4 0 10 H terr
OF TURBIGITY ICLEAR ISLIGHTLY CLOUDY AT ERG OF STORY	BENTONITE PELLET SEAL
ODOR OF	6 4 to 6 feet
WATER:	SAND PACK
WATER DISCHARGED GROUND SURFACE GTANK TRUCK TO: GSTORM SEWERS GSTORAGE TANK	6 10 23 teer
ODRUMS OTHER	2 INCH DIAMETER
DEPTH TO WATER AFTER DEVELOPMENT: FEET	SLOTTED: 0.010
MATERIALS USED	70.022
	2 INCH DIAMETER
3 SACKS OF 12-28 SAND	SCHEOUTE 40 PVC BLANK SILT TRAP
SACKS OF Port . TYPE TE CEMENT	E_toleet
GALLONS OF GROUT USED 25.1	BOTTOM WELL CAP
SACKS OF POWDERED BENTONITE	<u>≥3.1</u> feet
POUNDS OF BENTONITE PELLETS	HOLE CLEANED OUT TO
10 6 FEET OF INCH PVC BLANK CASING	
15 FEET OF 2 INCH PYC SLOTTED SCREEN	BOTTOM OF BOREHOLE
YARO ³ CEMENT-SAND (REDI-MIX) ORDERED	NOT TO SCALE
YARDI CEMENT-SAND (REDI-MIX) USED	ADDITIONAL INFORMATION:
CONCRETE PUMPER USED? NO DYES	riser + screen steam
NAME	clouned
WELL COVER USED: TOCKING STEEL COVER	* prior to cut-off
רוחדשבט	## A P P



FIELD WELL COMPLETION	FORM	•			CHRISTY BOX
					TLOCKING STEEL COVER
NAME: BAFB JP-	1 site				6 INCH DIAMETER
108" L599	PROJECT T	Melsan	. 7		STEEL CONDUCTOR CASING
LOGGEO a. Cheukins	EDITED 7	Lewis	11		tofeet
WELL MW-200		4/28			THE INCH DIAMETER
ORILLING COMPARY: A.W. FOCI					toleet
EQUIPMENT: / TY.	LLOW STEM AUGER	G. Pool			BENTONITE-CEMENT
21	TARY WASH	HOURS DRILLED:		1	8-SACK CEMENT-SAND
GALLONS OF WATER	2	GALLONS			tofer
METHOD OF DECONTAMINATION	Pressure	1		-	2.5) ** TOP OF CASING AT
	steem cleer	7/19	1		*3.5 FEET ABOVE
DEVELOPMENT			'.		SELOW GROUND LEVEL
DEVELOPMENT: Bailing				-	BOREHOLE
SEGAN DATE:	TIME:	DATES			<u>0 :0 23 teet</u>
GPM FROM	τό	OATE		j	3 INCH DIAMETER
GPM FROM	סיו				BLANK CASING +3.5 to 6.6 leet
GPM FROM	то	DATE			SENTONITE-CEMENT
GPM FROM	та	DATE		-	SEAL OR BACK CEMENTSAND
TOTAL WATER REMOVED		GALLONS			SEAL 3.7 (a.9)
DESCRIPTION OF TUNBIDITY DELEAR	D St	LIGHTLY CLOUDY	3.7'-		BENTONITE PELLET
SEVELOPMENT: UMOD. T	v 🔲 aissu	ERY MUDDY	,		SEAL 3.7:0_6_'eet
ODOR OF WATER:	•		- 6 -		
WATER DISCHARGED DISCHARGED	JRFACE TANK	TRUCK			SAND PACK
☐STORM SEW	ERS STOR	AGE TANK			2 INCH DIAMETER
BEPTH TO WATER		FEET	E.		SLOTTED : 0.010
MATERIALS USED		7251			6.6 :021.6 test
			•		INCH_BIAMETER
3 SACKS OF 12-		SAND			SCHEDULE 40 PVC BLANK SILT TRAP
SACKS OF Port	- Type II	CEMENT	г		1021.6 INT
GALLONS OF GROU	TUSED		25.1		BOTTOM WELL CAP
SACKS OF POWDER			3.5		21-7 teen
25 POUNDS OF BENTON	kite Pellets		1.6		HOLE CLEANED OUT TO
10 FEET OF 2 INCH					BOTTOM OF BOREHOLE
1-0.1' SEVEW ON		EEN			23_ten
YARO ³ CEMENT-SAN		ERED .		NOT TO SC.	ALE -
YARD CEMENTISAL				ADDITION	al information:
CONCRETE PUMPER USED?	THO THES			rism	screen steam
NAME		-	-	elean	1
WELL COVER USED: VZLOCKIN			;	* paix	to cut-off



	MPLETION FORM	•	CHRISTY 80X
BAFB	Site JP-1	•	ELOCKING STEEL O
De LS9			STEEL CONDUCTO
	I ' EDITI		
VELL MIN	202	1 4/29 /c	774 INCH DIAM
MILLING A	203	4/29/	BOREHOLE
OMPANY: H.W	1. Pool		BENTONITE-CEM
B-12	4 INCH HOLLOW ST	HOURS	SEAL OR SEAL CEMENTS
ALLONS OF WATER	INCH ROTARY W	ASH ORILLED:	- II III SEAL -
SED DURING ORILL	THE	GALLONS	Z.67 **
ETHOS OF DECONT	pressure	steam	TUP OF CASING
EVELOPMENT			# # OFEET ABOV
ETHOD OF EVELOPHENT:	bailing		74 INCH DIAM
EVELOPMENT EGAN DATE:	71=2	· ·	BOREHOLE O 10 28 I
	IME: ROM YO	GATE:	Z INCH DIAM
IELD: T	IME: ROM TO	DATÉ:	SCHEDULE 40 PV BLANK CASING
ILLD: T	NE:	DAYE:	+40 to 6.0 t
IELO: T	IME;	DATE:	SEAL OR
CTAL WATER REM		1	B-SACK CEMENT
ESCRIPTION		GALLONS.	
TURBIOLTY TEND OF EYELOPMENT:	CLEAR	SLIGHTLY CLOUD	SEAL SEAL
DON OF	EMOD, TURBID	VERY MUDDY	
ATCR:	700000000000000000000000000000000000000	The same with the same	= 12-28 S
HECHARGED .	Iground surface Istorm sewers	☐ TANK TRUCK ☐ STORAGE TANK	5 to 27
	DRUMS	OTHER	
EFTER DEVELOPME	NT:	FEET	SLOTTED : O.
MATERIALS USED		.•	6:021
5 sacre	of	S SAND	SCHEDUL 40 P
SACKS	0 / 5		BLANKSILT TH
	NS OF GROUT USED		BOTTOM WELL
	OF POWOERED BENT	ONITE	21.1 leer
	S OF BENTONITE PEL	_	5. 1 HOLE CLEANED
	F Z INCH PVC BL		4 ~ <u>27</u> 1m
15 FEET O	F 3 INCH PVC SLC	TTEO SCREEN 21	1.1 SOTTOM OF BOI
1-0-13	bew on both.	cap :	<u>all</u> for
	CEMENT-SAND IREDI		NOT TO SCALE
	CEMENT-SAND (RED)	MIXI USED	ADDITIONAL INFORMATION:
CONCRETE PUMPER	USED? ZNO	TYES	* prior to cut-off
NAME		· ·	** After 1-33 cut off an
well cover used:			survey completed.



FIELD WELL COMPLET	ION FORM			CHRISTY BOX
100 Caler AF	D			LOCKING STEEL COVER
JOB NUMBER: 01/4	PROJECT MANAGER:	AT	41-57-	INCH DIAMETER STEEL CONDUCTOR CASING
LOGGED 13DH	EDITED			tofeet
WELL MW205		4 19/95		INCH DIAMETER
DRILLING Tri- Styl	o Tot.	17.19773		tofeet
EQUIPMENT:	HOLLOW STEM AUG	ER DRILLER T POUR		BENTONITE CEMENT
_	ROTARY WASH	HEURS DRILLED:		8 SACK CEMENT SAND
GALLONS OF WATER	NA	GALLONS		tofeet
METHOD OF DECONTAMINATION TO DRILLING:		(A. A.		TOP OF CASING AT
DEVELOPMENT	·	your		2.6 FEET ABOVE AT
METHOD OF SER TA	sci prosco	ement trees		101 INCH DIAMETER
DEVELOPMENT BEGAN DATE:		11(40) 70(4)		BOREHOLE D to 2 1.5 feet
YIELD: TIME:	TIME:	DATE:		2 INCH DIAMETER
GPM FROM	то	DATE:		SCHEDULE 40 PVC BLANK CASING
GPM FROM	то	DATE:		+ 2.b 10 9.1 feet
GPM FROM	то	DATE:		D BENTONITE-CEMENT
GPM FROM	το			8-SACK CEMENT-SAND
DESCRIPTION		GALLONS		0 10 5.0 feer
OF TURBIDITY CLEAR AT END OF DEVELOPMENT: CLEAR DEV	_	SLIGHTLY CLOUDY VERY MUDDY		BENTONITE PELLET SEAL
DOR OF	, 10NS10	VERT MODET		5.0 to 7.0 teet
WATER GED GROUND	SURFACE TAN	K TRUCK		SAND PACK
ro: □STORM S		RAGE TANK		7.0 10 21.5 feet
DRUMS	□отн			2 INCH DIAMETER SLOTTED (0.01
MATERIALS USED		FEET		inch · SCREEN
		4		9.1 to 19.1 feet
10.5 SACKS OFH	20/40 Mb.	bay MUSANO		2 INCH DIAMETER SCHEDULE 48-90 S BLANK SILT TRAP
SACKS OF		CEMENT		19.1 to 21.1 feet
GALLONS OF GRO				BOTTOM WELL CAP
75 SACKS OF POWDE				21.1 feet
7	ONITE PELLETS CH PVC BLANK CASI	NC		HOLE CLEANED OUT TO
70.0 FEET OF 2 INC	SS STORY	RENEWALL		80110MOS-80REHOES
2.0 feet of 2	inch stable	they were	And the second s	
YARO CEMENTS	AND (REDIMIX) ORC	DERED	NOT TO SC	The state of the second section in the second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the second section in the second section is a second section in the section is a second section in the second section in the second section is a second section in the section is a section in the section in the section is a section in the section in the section is a section in the section in the section in the section is a section in the section in the section in the section is a section in the section in the section in the section in the section is a section in the sec
YARD3 CEMENT-S	AND (REDI-MIX) USE	D	ADDITION	AL INFORMATION:
CONCRETE PUMPER USED?	NO TES			
NAME				
WELL COVER USED: LOCKI				
□ CHRIS □ OTHER				



FIELD WELL COMPLETION FORM	CHRISTY BOX
	□ LOCKING STEEL COVER
NAME: CALL AFB	INCH DIAMETER
NUMBER: 0114 MANAGER: AT	CASING
LOGGED BDH EDITED	tofeet
DATE	195 INCH DIAMETER
DRILLING X . DOLD K. L	tofeet
EQUIPMENT: (T) DRILLER;	BENTONITE CEMENT
INCH HOLLOW STEM AUGER HOURS	SEAL OR BEACK CEMENT SAND
GALLONS OF WATER USED DURING DRILLING: NA GALLONS	NA tofeet
METHOD OF DECONTAMINATION Agan Chare	TOP OF CASING AT
DEVELOPMENT	2-4 FEET ABOVE AT
METHOD OF . DEVELOPMENT:	BOREHOLE
DEVELOPMENT BEGAN DATE: TIME:	D to 2).0 feet
VIELD: TIME: DATE:	2 INCH DIAMETER
YIELD: TIME: DATE:	SCHEDULE 40 PVC BLANK CASING
YIELD: TIME: DATE:	+ 2.4 to 11.0 feet
YIELD: TIME: DATE:	BENTONITE-CEMENT SEAL OR SACK CEMENT-SAND
TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS	SEAL 0 10 5 0 feet
DESCRIPTION CLEAR SLIGHTLY CLO	NUDY NOON
AT END OF DEVELOPMENT: MOD. TURBID VERY MUDDY	BENTONITE PELLET SEAL 5.0 to 9.0 feet
ODOR OF WATER:	
WATER GROUND SURFACE TANK TRUCK	SAND PACK
STORM SEWERS STORAGE TANK	9.0 to 23.0 feet
DRUMS OTHER	
DEPTH TO WATER AFTER DEVELOPMENT: FEET	SLOTTED (_D, D/
MATERIALS USED	11.0 to 23.0 feet
10 1 SACKS OF 50/b 20/40 Morie SA	INCH DIAMETER SCHEDULE 40 PVC 5.5. BLANK SILT TRAP
	MENT BLANK SILT TRAP
GALLONS OF GROUT USED	BOTTOM WELL CAP
SACKS OF POWDERED BENTONITE	23.0 feet
100 POUNDS OF BENTONITE PELLETS	HOLE CLEANED OUT TO
13.5 FEET OF 2 INCH PVC BLANK CASING	23.0 feet
10-0 FEET OF 2 INCH PVC SECTION SCREEN	BOTTOM OF BOREHOLE
20 fact of 2 mb Sis alt they	23.D (cet
YARD ³ CEMENT-SAND (REDI-MIX) ORDERED	NOT TO SCALE
YARD CEMENT-SAND (REDI-MIX) USED	
	ADDITIONAL INFORMATION:
CONCRETE PUMPER USED? NO YES	
WELL COVER USED: LOCKING STEEL COVER	
CHRISTY BOX	
□ OTHER	



FIELD WELL	COMPLETION FOR	IM .		CHRISTY BOX
				D LOCKING STEEL COVER
NAME: OUL	PRO	VIECT AT	— 4 1- 5-	INCH DIAMETER STEEL CONDUCTOR CASING
LOGGED	EDI	TED		tofeet
BY: 31		DATE:/		INCH DIAMETER
NAME: MW	207	PAIF/10/	95	BOREHOLE
COMPANY:	n- store 2	orling		tofeet
EQUIPMENT:	14 ID INCH HOLLOWS	TEM AUGER DELLER:	Bayer !	BENTONITE-CEMENT SEAL OR
0_	INCH ROTARY	NASH HOURS		8 SACK CEMENT SAND
GALLONS OF WAT	ILLING: NA	GALLONS		tofeet
METHOD OF DECO		on Canas		TOP OF CASING AT
DEVELOPMENT				7.5 FEET ABOVE AT
METHOD OF DEVELOPMENT:				104 INCH DIAMETER
DEVELOPMENT	TIM		 -	BOREHOLE D to 23. b leet
TIELD:	TIME:	DATE:		2 INCH DIAMETER
YIELD:	FROM TO	DATE:		SCHEDULE 40 PVC BLANK CASING
GPM YIELD:	FROM TO	DATE:		+2.5 10 11.6 feet
GPM	FROM TO	DATE:		DE BENTONITE CEMENT
GPM	FROM TO			SEAL OR 8-SACK CEMENT-SAND
TOTAL WATER RE		GALLONS		SEAL 0 10 7.0 feet
DESCRIPTION OF TURBIDITY AT END OF	CLEAR	SLIGHTLY CLO	UDY	BENTONITE PELLET
DEVELOPMENT:	MOD. TURBID	VERY MUDDY		SEAL 7.0 :0 9.0 'eet
ODOR OF WATER:				NAME NUMBER
WATER DISCHARGED	GROUND SURFACE			SAND PACK
TO:	☐STORM SEWERS ☐DRUMS	STORAGE TANK		
DEPTH TO WATER		FEET		SLOTTED (0.0)
MATERIALS US		PEE!		inch SCREEN
		1	_ -	11.6 to 21.6 feet
92 SACK	s of 50/b 20	140 grone SA	ND	SCHEDULE 40 PVC 5.5 BLANK SILT TRAP
SACK	s of	CE	MENT	21.6 10 23.6 leet
GALL	ONS OF GROUT USED			BOTTOM WELL CAP
	S OF POWDERED BENT			23,6 teet
	IDS OF BENTONITE PEL			HOLE CLEANED OUT TO
	OF 2 INCH PVC BL	ANK CASING		2 <u>3. h</u> 1-et
FEET	OF 2 INCHEVEST	OTTED SCREEN		BONTOM OF BOREHOLE
44 4 4 4 4	tof2 inch	COLUMN TO THE STATE OF THE STAT		
	CEMENT-SAND (RED		NOTTO	TSCALE
	CEMENT-SAND (RED	I-MIX) USED	ADDITI	IONAL INFORMATION:
CONCRETE PUMPE	ER USED7 NO	□YES		
NAME				
WELL COVER USE	D: LOCKING STEEL CHRISTY BOX	. COVER		
	OTHER			

FIELD WELL COMPLETION FORM	CHRISTY BOX
NAME: Eaker AFB	□ LOCKING STEEL COVER
NUMBER: 0114 PROJECT MANAGER: Allan Jenkins	INCH DIAMETER STEEL CONDUCTOR CASING
EDITED ENTED	tofeet
NAME: MW 211 - 8115195	BOREHOLE
COMPANY: In State Testing Services	tofeet
DRILLER:	BENTONITE CEMENT
INCH ROTARY WASH HOURS	SEAL OR B. SACK CEMENT SAND
GALLONS OF WATER USED DURING DRILLING: GALLONS	TOfeet
METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Cleaning	
DEVELOPMENT Well Development Form	TOP OF CASING AT
METHOD OF DEVELOPMENT:	BELOW GROUND LEVEL
DEVELOPMENT BEGAN DATE:	BOREHOLE
YIELD: TIME: DATE:	0 :0 21 feet
YIELD: TIME: DATE:	SCHEDULE 40 PVC
GPM FROM TO	BLANK CASING
GPM FROM TO	O to 9 feet
GPM FROM TO	SEAL OR
DURING DEVELOPMENT: GALLONS DESCRIPTION	8-SACK CEMENT-SAND
AT END OF	O 10_5 leet
DEVELOPMENT: MOD. TURBID VERY MUDDY	BENTONITE PELLET SEAL
ODOR OF WATER:	5 :0 7 'eet
DISCHARGED GROUND SURFACE TANK TRUCK	SAND PACK
STORM SEWERS STORAGE TANK ODRUMS OTHER	7 10 21 teet
AFTER DEVELOPMENT	a INCH DIAMETER
MATERIALS USED	SLOTTED (.O.O)
072495 GA DONNELL	9 to 19 feet
11 SACKS OF Morie 20140 Fi Hration media SAND	SCHEDULE 40 PVC SS.
SACKS OFCEMENT	BLANK SILT TRAP
20 GALLONS OF GROUT USED	
SACKS OF POWDERED BENTONITE	BOTTOM WELL CAP
750150 17 POUNDS OF BENTONITE PELLETS 1/2 buckets	
15 FEET OF _ INCH PVC BLANK CASING WI 2.5 ft. C wt of	21 1981
d Fl ct 2 inch ss. silt trap	BOTTOM OF BOREHOLE
YARO3 CEMENT-SAND (REDI-MIX) ORDERED	NOT TO SCALE
YARD CEMENT-SAND (REDI-MIX) USED	1 101 1
CONCRETE PUMPER USED? TO DYES	ADDITIONAL INFORMATION:
NAME mixed in a 55 gal.	Calculated sand= 10.92 sades
WELL COVER USED: SLOCKING STEEL COVER CHRISTY BOX	Calculated grout = 19.6 gal
OTHER	



FIELD WELL COMPLETION FORM	CHRISTY BOX		
108	LOCKING STEEL COVE		
NAME: Eaker AFB PROJECT: Allan Jenkins NUMBER: 0114 MANAGER: Allan Jenkins	INCH DIAMETER STEEL CONDUCTOR CASING		
LOGGED G. Millar EDITED	tofeet		
WELL DATE:	INCH DIAMETER		
NAME: TW1501 8/27/95	BOREHOLE .		
EQUIPMENT: (-11)			
MATCHY INCH HOLLOW STEM AUGER M. TOHY	BENTONITE-CEMENT SEAL OR		
INCH ROTARY WASH	8 SACK CEMENT SAND		
GALLONS OF WATER USED DURING DRILLING: 5 GALLONS	tofeet		
METHOD OF DECONTAMINATION PRIOR TO DRILLING: Steam Cleaning	TOP OF CASING AT		
DEVELOPMENTSEE WELL DEVELOPMENT Form	3 FEET ABOVE AT		
METHOD OF			
DEVELOPMENT: DEVELOPMENT	BOREHOLE		
EGAN DATE: TIME:	0 :0 16 · Steet		
GPM FROM TO	2 INCH DIAMETER		
GPM FROM TO	SCHEDULE 40 PVC BLANK CASING		
GPM FROM TO	+3 to 6 feet		
GPM FROM TO	● □ BENTONITE-CEMENT SEAL OR		
OTAL WATER REMOVED	8-SACK CEMENT-SAND		
ESCRIPTION			
F TURBIDITY CLOUDY T END OF EVELOPMENT:	BENTONITE PELLET		
MOD. TURBID VERY MUDDY	SEAL O :0 4 'eet		
ATER:	morie 20/40 OON		
ATER GROUND SURFACE TANK TRUCK	SAND PACK		
DRUMS □ STORAGE TANK □ DRUMS □ OTHER	4 10 1615 leet		
PTH TO WATER	2 INCH DIAMETER		
ATERIALS USED	SLOTTED (. O 10		
	6 to 16 feet		
5 3/4 SACKS OF SAND	SCH SQULE TO PVC		
NA SACKS OFCEMENT	BLANK SOLT TRAP		
MA GALLONS OF GROUT USED	toleet		
MA SACKS OF POWDERED BENTONITE	BOTTOM WELL CAP		
75 POUNDS OF BENTONITE PELLETS 1.5 buckets	HOLE CLEANED OUT TO		
10 FEET OF 2 INCH PVC BLANK CASING I FT OF CUT OFF:	16.5 Inet		
10 FEET OF 2 INCH PVC SLOTTED SCREEN	BOTTOM OF BOREHOLE		
YARD ³ CEMENT-SAND (REDI-MIX) ORDERED	NOT TO SCALE		
YARD CEMENT-SAND (REDI-MIX) USED			
ONCRETE PUMPER USED? THO THES	ADDITIONAL INFORMATION:		
AME	calculated sand = 6.25 bogs		
ELL COVER USED: LOCKING STEEL COVER			
CHRISTY BOX			
MOTHER Temp Well			

FIELD WELL COMPLETION FORM			_	CHRISTY BOX	
NAME: EAKER AFB	LOCKING STEEL COVE				
NAME: CHAER HPB	PROJECT A	LLAN JENKINS	4	INCH DIAMETER STEEL CONDUCTOR CASING	
LOGGED BY: B, MC(ANLESS	EDITED BY:			tofeet	
WELL TWIS 02	•.	DATE:		- INCH DIAMETER	
DRILLING		8/28/95		BOREHOLE .	
COMPANY: TRI STATE		DRILLER:		BENTONITE-CEMENT	
₩ // 4 INCH HO	LLOW STEM AUGE	M, TOTTY		SEAL OR	
	TARY WASH	DHILLED: 1		SEAL	
USED DURING DRILLING:		GALLONS		tofeet	
METHOD OF DECONTAMINATION PRIOR TO DRILLING:	STEAM C	LEAN	, —	TOP OF CASING AT	
DEVELOPMENT				FEET ABOVE AT	
METHOD OF DEVELOPMENT: SEE DE	VELCPME	- 14 T- 12 C-00		- 714 INCH DIAMETER	
DEVELOPMENT BEGAN DATE:		NI POTOTI		GONEROLE	
YIELD: TIME:	TIME:	DATE:		0 :0 18,5 feet	
GPM FROM	то	DATE:		SCHEDULE 40 PVC	
GPM FROM	то .	DATE:		BLANK CASING	
GPM FROM	то			GENTONITE-CEMENT	
GPM FROM	то	DATE:		SEAL OR SEACK CEMENT-SAND	
TOTAL WATER REMOVED DURING DEVELOPMENT:		GALLONS		SEAL	
DESCRIPTION OF TURBIDITY DELEAR	□s∟	IGHTLY CLOUDY	***	feet	
AT END OF DEVELOPMENT: MOD. TU		RY MUDDY		BENTONITE PELLET	
ODOR OF WATER:				0 :0 6 'eet	
WATER GEO GROUND SURFACE TANK TRUCK		TRUCK	1 = +	MORSECO. 20140 [name] [number; SAND PACK	
TO: STORM SEWERS STORAGE TAN		· · - - ·		6 1018,5 teet	
DEPTH TO WATER	, DOTHER			2 INCH DIAMETER	
AFTER DEVELOPMENT: FEET				SLOTTED (O.O.C.)	
MATERIALS USED				8 to 18 feet	
S SACKS OF MORIE	CO. FILTO	ATEONSANDIA	*	- INCH DIAMETER	
NA SACKS OF		CEMENT		SCHEDOLE 40 PVC BLANK SPLT TRAP	
NA GALLONS OF GROUT USED				fo feet	
NA SACKS OF POWDERED BENTONITE				BOTTOM WELL CAP	
POUNDS OF BENTONITE PELLETS 1.34 BUCKETS					
10 FEET OF 2 INCH PVC BLANK CASING				HOLE CLEANED OUT TO	
(C FEET OF 2 INCH PVC SLOTTED SCREEN				BOTTOM OF PORTUGIES	
	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3			18,5 leet	
YARD3 CEMENT-SAND	(REDI-MIX) ORDER	ED	NOT TO SCALE		
YARD CEMENT-SAND (REDI-MIX) USED					
CONCRETE PUMPER USED? NO TYES		ADDITIONAL INFORMATION:			
NAME			CALCULATED SAND=		
VELL COVER USED: DLOCKING STEEL COVER					
□CHRISTY BOX					
DOTHER TEMPORARY WELL				. 1	



FIELD WELL CO	OMPLETION FO	RM	•					CHRISTY BOX	
JOB	265		· · · · · · · · · · · · · · · · · · ·	•				LOCKING STEEL COVE	R
101	Y BFB	DIECT		•	41_	17	┸╬┼	INCH DIAMETER	
HUMBER: OHY		HAGER: A	Ian Jenkir	18			$\parallel \parallel$	CASING	
ex: G. Mi	Ilar iv							tofeet	1
NAME: TWI	503		29175					BOREHOLE .	
COMPANY: Tri S	tale Test	ina Su	rvices				Π	tofeet	
EQUIPMENT: 7	4 INCH HOLLOW	STEM AUGER	MITOHY				 - -(BENTONITE-CEMENT	
0	INCH ROTARY	WASH	HOURS ORILLED:		-		14-1	B-SACK CEMENT-SAND	
GALLONS OF WATER	.ING:	5	GALLONS to hi	ydra	K	•	•	tofeet	
METHOD OF DECONT	AMINATION SHEAV	2.1				~		TOP OF CASING AT	
DEVELOPMENT &	see Well t			^			1	FEET BOVD AT	
METHOD OF DEVELOPMENT:	ex war u	-W-Clob	neva Form						-
DEVELOPMENT								BOREHOLE	
WIELD: TI	TIM ME:		DATE:					0:016 leer	
	IOM TO		DATE:			4		SCHEDULE 40 PVC	
GPM FR	ом то						١.	BLANK CASING	
GPM FR	ME: OM TO		DATE:				1	-3 10 5:51et	
GPM FR	ME: OM TO	C	DATE:			-		SEAL OR	
TOTAL WATER REMODURING DEVELOPME	VED NT:	G	ALLONS			-		SEAL	
DESCRIPTION OF TURBIDITY	CLEAR	□sug	HTLY CLOUDY		1888			O TO leer	
AT END OF DEVELOPMENT:	MOD. TURBID	_	Y MUDDY					BENTONITE PELLET SEAL	
DOR OF						***		0 10 315 leet	L
NATER DISCHARGED	GROUND SURFACE	☐ TANK TR	IIICK		1 }	= •		MOVIC 20/40 COS	-70
· o :	STORM SEWERS	STORAG						3,5 10 16,0 leet	
EPTH TO WATER	DRUMS .	OTHER_				= -		2 INCH DIAMETER	
FTER DEVELOPMENT	ſ:	F	ET					SLOTTED (0/6/0)	
ATERIALS USED								5,5 to 15,5feet	
5 1/16 SACKS OF	605 PHETO	4 OGNIVE	ichnedia			-		INCH DIAMETER	
SACKS OF		<u> </u>						BLANK SILT TRAP NA	
GALLONS			CEMENT					to leet	
SACKS OF POWDERED BENTONITE				4	- →-		BOTTOM WELL CAP		
75 POUNDS C	F BENTONITE PELL	ETC ///a	buchite			l		15,5 leet , 5' sand	1
75 POUNDS OF BENTONITE PELLETS 1 1/2 buckets 10 FEET OF 2 INCH PVC BLANK CASING 1.51 CUt Off							HOLE CLEANED OUT TO		
10 FEET OF	2 INCH PUCSION	TED SCOTT	1.2 · Cus OF	·					
		I CO SCREEN		į				BOTTOM OF BOREHOLE	
YARO ³ CE	MENT-SAND (REDI-	MX) ORDERF)	F.	NOT	O SCAL	E		
YARD3 CE	MENT-SAND (REDI-	MIX) USED							
ONCRETE PUMPER US		YES						and = 612 sadics	
AME	<i>r</i> = =				-are	LL CLUPCE	x 340	ru = wia sacks	
ELL COVER USED:	LOCKING STEEL C	OVER							
	ICHRISTY BOX LOTHER <u>Tem</u>	o Well							



FIELD WELL COMPLETION FORM	CHRISTY BOX			
NAME: EAKER AFB	O LOCKING STEEL COVER			
108 HUMBER: 0114 PROJECT MANAGER: ALLAN JENKS	INCH DIAMETER STEEL CONDUCTOR CASING			
LOGGEOB. MCCANLESS EDITED	tofeet			
WELL TW1504 B127195	INCH DIAMETER			
DRILLING COMPANY TRISTATE TESTING	tofeet			
EQUIPMENT: 714 INCH HOLLOW STEM AUGER M. TOTTY	BENTONITE-CEMENT			
INCH ROTARY WASH HOURS	SEAL OR BASACK CEMENTSAND SEAL			
GALLONS OF WATER USED DURING BRILLING: GALLONS	tofeer			
METHOD OF BECONTAMINATION STEAM CLEAN	TOP OF CASING AT			
DEVELOPMENT	FEET ABOVE AT			
DEVELOPMENT: SEE DEVELOPMENT FORM	7114 INCH DIAMETER			
DEVELOPMENT BEGAN DATE: TIME:	BOREHOLE O 10 tees			
YIELD: TIME: DATE:	2 INCH DIAMETER			
YIELDI TIME: DATE:	BLANK CASING			
YIELD; TIME: DATE:	3 to <u>S.S.</u> feet			
YIELD: TIME: DATE:	SEAL OR			
TOTAL WATER REMOVED DURING DEVELOPMENT: GALLONS	SEAL SEAL			
OFSCRIPTION OF TURBIDITY OCLEAR OSLIGHTLY CLOUDY	PENTONITE PEN ST			
DEVELOPMENT: MOD. TURBID VERY MUDDY	BENTONITE PELLET SEAL			
ODOR OF WATER:	0 :03.5 'ect murre (a. 20/40)			
DISCHARGED DESCHARGED TANK TRUCK	SAND PACK			
TO: STORM SEWERS STORAGE TANK DRUMS OTHER	3.5 to 16 teet			
DEPTH TO WATER AFTER DEVELOPMENT: FEET	SLOTTED (0,010)			
MATERIALS USED	SS to ISS feet			
4				
NA SACKS OF MURIE CO. FILTRATISANO MEOS	SCHEDULE 40 PVC BLANK SILT TRAP			
NA SACKS OFCEMENT	fofeet			
NA SACKS OF POWDERED BENTONITE	BOTTOM WELL CAP			
75 POUNDS OF BENTONITE PELLETS 1.5 BUCKETS				
10 FEET OF 2 INCH PVC BLANK CASING 1.5' CUTUFF	HOLE CLEANED OUT TO			
10 FEET OF 2 INCH PVC SLOTTED SCREEN	BOTTOM OF BOREHOLE			
YARD ³ CEMENT-SAND (REDI-MIX) ORDERED	NOT TO SCALE			
YARD ³ CEMENT-SAND (REDI-MIX) USED	ADDITIONAL INFORMATION:			
CONCRETE PUMPER USED? WNO DYES	CALCULATED SANDE			
NAME	6.25 BAGS			
MELL COVER USED: LOCKING STEEL COVER				
WOTHER TEMPORARY WELL				

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	COMPLETION				OS YTEIRO D
LOS EAL	el arb	410 An			
NUMBER 3KG	R	PERMEY	CNA	4	STREE COND
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field well complet	ton form			☐ CHRISTY SQI
100 EAKER AFR	en de la		П	O LOCKING STEEL
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But Land		1-7-92	_	SCRENOLS
DESPERATE POOL DE		C0811.61		-C SENTONITE CE
	HOLLOW STEM ALIGER	V. BAZZA Z.Z.	_	SEAL OR
Lange of Water	actary wash		3 11	STAL .
an east of the same		GALLCAS		
THE OF BUILDING HIGH	PAESOBE STEM		1	TOP OF CASING
Ivelopment				C. 3 FEET ABOV
veldenery,	,			6'4 INCH DIAM
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Design Data		CHILL CITTON		- STATES TO PALL
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and the state of t	THE RESERVE THE PERSON NAMED IN COLUMN TWO IS NOT THE OWNER.			